

APPLICATION OF ATMOSPHERIC TRACER TECHNIQUES TO DETERMINE
THE TRANSPORT AND DISPERSION ASSOCIATED WITH THE LAND-BREEZE
MOVEMENT OF AIR OVER THE LOS ANGELES COASTAL ZONE

VOLUME 1 - EXECUTIVE SUMMARY

BY

FREDRICK H. SHAIR

CALIFORNIA INSTITUTE OF TECHNOLOGY
DIVISION OF CHEMISTRY AND CHEMICAL ENGINEERING
PREPARED FOR CALIFORNIA AIR RESOURCES BOARD

DECEMBER 2, 1982

A B S T R A C T

This report presents the results of seven atmospheric tracer tests in which sulfur hexafluoride was used to determine the transport and dispersion of pollutants associated with the Land and Sea Breezes of the Southern California Coastal region. Two elevated releases were made from the stack of a coastal power plant into off-shore flow. A dual tracer release was made from a ship moving north along the shipping lane between Long Beach and Ventura. Four additional releases were made from the surface during both Land and Sea Breezes. A significant portion of the tracer material released returned ashore during each test. Tracer released under off-shore flow conditions returned over a large section of the coast line whereas tracer released into a sea breeze maintained a narrower plume with higher concentrations found at greater downwind distances. The variation in plume characteristics from hour to hour and test to test reflected the complexities of the wind patterns of this region. Converging and diverging wind patterns along with flow reversals contributed to the large variations observed.

The statements and conclusions in this report are those of the Contractors and not necessarily those of the State Air Resources Board. The mention of commercial products, their source of their use in connection with material reported herein is not to be construed as either an actual or implied endorsement of such products.

INTRODUCTION

Seven large scale atmospheric tracer studies were conducted during 1977 and 1978 to probe the transport and dispersion associated with the land-breeze and sea-breeze circulation systems along the Southern California Coast. The primary tracer gas, sulfur hexafluoride (SF_6) was released during both on-shore and off-shore flow conditions. Four releases were made from land and three releases were made offshore from a boat. During one shipboard release a second tracer, bromotrifluoromethane (CBrF_3), was also released to provide more detailed resolution in the samples collected. Twenty-nine samplers were deployed along a section of the Coast extending from Corona Del Mar in Orange County to Ventura. In addition to these hourly-average samples, a large number of grab samples were collected by teams in automobiles, boats and airplanes. All tracer samples collected were analyzed and the results are presented in Volume 3 of this report.

A brief summary of each test will be presented in this volume. A summary of tracer releases and the maximum normalized concentration measured during each test is presented in Table 1. An extended summary of select tests and analyses of special topics are presented in Volume 2.

Tests 1 and 2 involved releasing SF_6 for a 5-hour period during each of two nights from stack #4 of the power plant operated by the Southern California Edison Company. Even though a portion of the plume was apparently injected above the base of the nighttime inversion, essentially all of the tracer was observed to return across a control surface (from sea level to the base of the inversion) along the coast throughout the sea breeze regime during the following day.

The residence time distribution functions of tracer material over the sea were almost identical in both experiments. The average residence time for tracer material over the ocean was 10 hours in both cases; however, some of the tracer spent as much as 16 hours out over the sea. The horizontal dispersion of tracer was also greater than had been expected, with between 75 and 100 km of coastline impacted by the return of SF_6 from a single elevated point source. Data from both shipborne and coastal monitoring stations indicate

that the path followed by the tracer over the ocean could not have been tracked accurately using trajectories constructed from conventionally available meteorological data. The results of tests 1 and 2, including a discussion of the physics of the mixing processes, are contained in Volume 2.

Test 3

The objective of test 3 was to determine the role of emission released from ship traffic operating in the prescribed shipping lane. A dual tracer release was made from the Naval Postgraduate School Research Vessel "Acania" for this study. Sulfur hexafluoride (SF_6) was released from 0530-1730 PDT as the ship moved along the shipping lane from Long Beach to a point in the Santa Barbara Channel about 25 km north of Santa Rosa Island (see fig. 1). A second tracer, Bromotrifluoromethane, was also released at 50 lbs/hr along two segments of the route (0530-0830 PDT, 1230-1730 PDT) in an attempt to provide more detailed resolution concerning the segment of the route that a given SF_6 sample came from. SF_6 was detected during the course of the test at all twenty-nine sampling sites shown on figure 1. The highest concentrations were recorded at the southern sites during the on-set of the sea breeze.

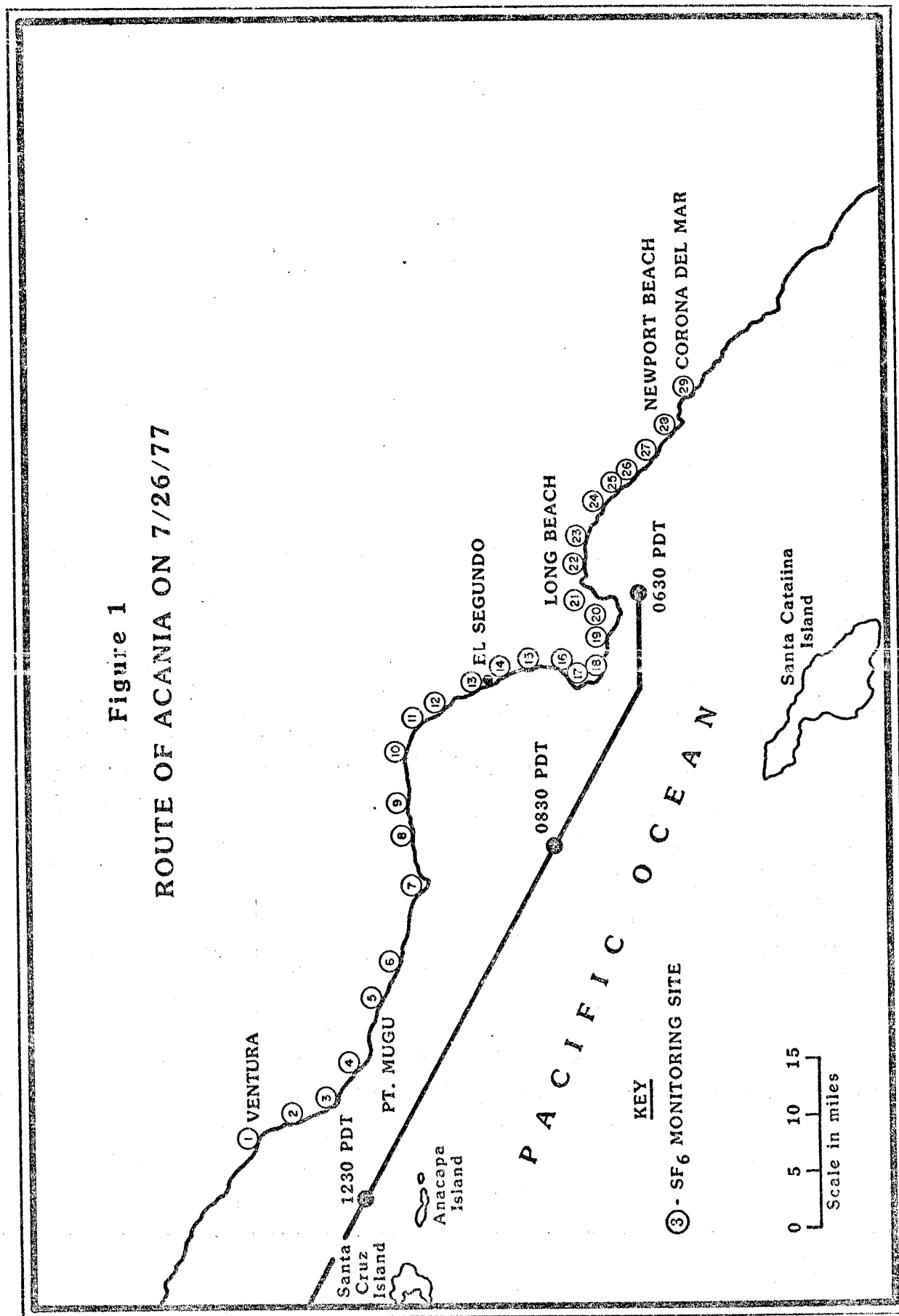
Test 4

Sulfur hexafluoride was released from the Acania in the middle of the Santa Barbara Channel between 0502-0714 PDT from a location about 25 KM North of Santa Rosa Island. Grab samples collected in Santa Barbara and Ventura Counties indicated that the tracer concentrations were highest in Santa Barbara County, with some lower concentrations recorded in the Ventura area. This pattern suggests that the heaviest impact was beyond the hourly-average sampler network. The maximum normalized concentration reported was 9616 PPT/lb-mole hr^{-1} and came from a grab sample collected near Santa Barbara.

Test 5

A shore line release of SF_6 was made from the surface at El Segundo between 0200-0430 PDT on September 8, 1977. Off-shore flow prevailed during the release and the plume initially moved seaward and returned back onshore after the onset of the sea breeze. The converging wind pattern at the interface between the land-breeze and sea-breeze regimes together with flow reversals

Figure 1
ROUTE OF ACANIA ON 7/26/77



T A B L E 1

SF₆ TRACER DATA

TEST NO.	DATE	RELEASE LOCATION	RELEASE TIME (PDT)	** MAXIMUM SF ₆ CONCENTRATION	LOCATION OF MEASURED MAXIMUM CONCENTRATION
1	7/22/77	SCEPP* (elevated)	0005-0500	277	Playa Del Rey
2	7/23-24/77	SCEPP* (elevated)	2303-0400	244	Manhattan Beach
3	7/26/77	Shipping Lane (Fig.2)	0530-1730	2577	Sunset Beach
4	7/28/77	Middle of Santa Barbara Channel	0502-1714	9615	Santa Barbara
5	9/8/77	SCEPP* (surface)	0200-0430	566	Malibu
6	9/13/77	Twenty-Two Miles West of SCEPP*	0900-1400	796	Manhattan Beach
7	7/13/78	SCEPP* (Surface)	0900-1500	6562 (Grab Sample)	Eight Miles Down Wind of Release Site

* SCEPP - Southern California Edison Power Plant at El Segundo (Unit 4)

** Concentration Normalized to PPT/LB-MOLE SF₆ HR⁻¹

during the transition period appear to have mixed the plume and spread it over a large area. The tracer was detected at samplers located over a twenty mile wide zone and concentrations were relatively dilute. The major part of the plume returned on-shore north of the release site and a maximum normalized hourly average concentration of 339 PPT/lb-mole hr^{-1} was recorded in the Malibu area.

Test 6

An off-shore release of SF_6 was made between 0900-1400 PDT on September 13, 1977. The release was made from a boat about twenty-two miles due west of El Segundo at the on-set of the sea breeze. The plume moved directly onshore near El Segundo and covered a ten mile wide section of the Coast line. The highest normalized hourly average tracer concentration measured during this test was 796 PPT/lb-mole hr^{-1} collected at Manhattan Beach.

Test 7

SF_6 was released from the surface at El Segundo during the period 0900-1500 PDT. The tracer moved eastward across the Los Angeles basin and passed thru Banning Pass at 2000 PDT and concentrations in the pass remained above 10 PPT until 0445 PDT the following day. A traverse on the afternoon after the tracer release along highway 534 near the Colorado River measured SF_6 concentration along a segment over 85 miles long with numerous SF_6 concentrations over 10 PPT.